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NOVEMBER 25, 1940

VOLUME 29 NUMBER 24

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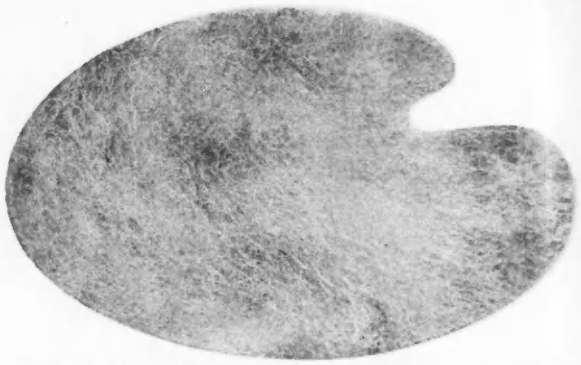
FOR GOVERNMENT SHADES ON WOOL



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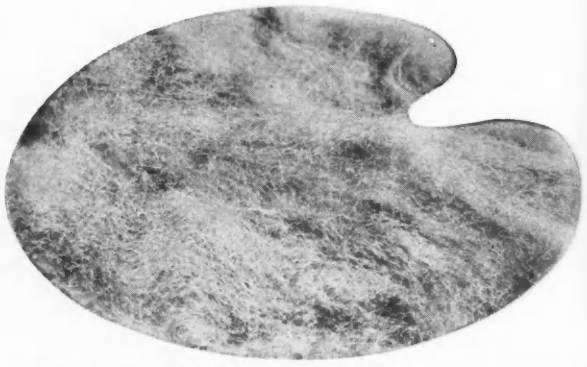

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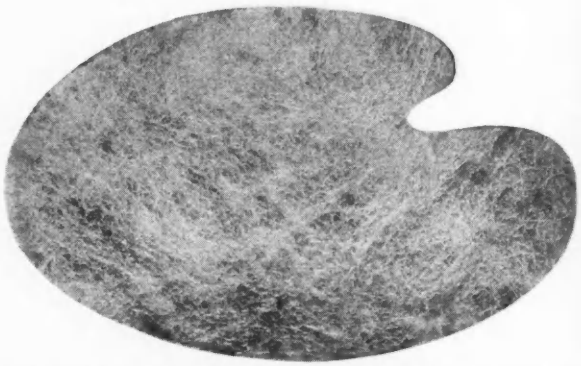

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DYESTUFF REPORTER

VOLUME 29 NOVEMBER 25, 1940 NUMBER 24

Rayon Dyeing and Finishing*

E. HAZELEY, B.Sc.

DYEING and finishing, because the dyer's work is the last work that is done on the fabric, and faults on the examination table are sometimes unjustly attributed to the dyer, when the dyer's work only brings to light mistakes of the departments concerned earlier in the production of the cloth. As a rayon producer I made an investigation into the problems connected with dyeing and finishing, and they resolved into three groups, which can be corrected in the dyehouse.

(1) FAULTS CORRECTABLE IN DYEING

Water.—A customer complained that our bright yarn was not as lustrous as formerly after it had been dyed in the hank. A number of dyed skeins were submitted to illustrate this complaint, some of which were almost as dull as our matt yarn. It was noticed that the affected yarn was also harsh and sticky to handle, and when examined under the microscope the filaments were found to be coated with some foreign matter. When treated in a solution of sodium hexametaphosphate or other compounds, this dull yarn regained its normal luster and softness of handle because the insoluble calcium and magnesium soaps, with which the filaments had become coated, were converted to soluble sodium soap. This customer did not soften the water used for dyeing and the supply was quite uncertain in this respect. A sudden change in the chemical nature of the water had caused considerable trouble in the dye-house.

This was an extreme case but the point can be made that even small amounts of metallic pollution in the water used for dyeing can cause numerous faults in the finished goods, such as variation in luster and handle, streaky or blotchy dyeing, etc. For all wet processing of viscose rayon, properly softened and purified water is necessary. Quite a number of manufacturing concerns are still of the opinion that once having analyzed the hardness of their water supply, that it will remain constant. Tests of river water showed a variation from 226.5 to 420.6 parts, at various times of the year. The St. Lawrence River water varied considerably at various points along its route.

Where there is any doubt about the condition of the water, the use of a softener in the dyeing and finishing baths will help a lot in inhibiting the formation of insoluble metallic soaps upon the goods.

Bleaching.—A very troublesome case was brought to our attention of small holes developing in circular knitted goods which had been bleached with hydrogen peroxide. The customer was using two methods of bleaching—sodium hypochlorite for bleached whites and hydrogen peroxide for fabric to be subsequently dyed in pastel shades. The holes were only found to occur in those pieces which had been bleached with peroxide and they appeared during finishing when some stretch was applied to the fabric on the spreader. When the customer went over to sodium hypochlorite for bleaching all of the goods, no further trouble was experienced with holes. In the affected goods it was found that there were signs of severe cellulose degradation at the ends of the ruptured filaments. To use peroxide as a bleaching agent, very thorough scouring and preparation of the grey goods must be carried out in order to prevent holes from developing.

Peroxide, it is true, gives a brilliant white and is a basis for brilliant pastel shades. It is also very convenient and saves costs when used in the dyebath, but the brilliancy and saving in costs are usually offset by the lowering of the strength of the yarn. The relative properties of hypochlorite and peroxide is a debatable subject—both are good—but the illustration emphasizes the need of chemical control when using a bleach of any type.

Test for Degradation of Cellulose.—A routine test for degradation of viscose cellulose yarns conducted in our laboratories is as follows:

Solution A. { 8 per cent NaOH
{ 8 per cent $Na_2S_2O_3$
Solution B. (A 2 per cent solution of silver nitrate.

Mix equal volumes of each solution but take care to add solution B., that is, silver nitrate, to the other solution, as otherwise a difficult soluble silver oxide is precipitated. Boil the mixed solutions and then add a piece of the

*Address of Courtaulds (Canada) Limited to the Canadian Association of Textile Colourists and Chemists, reported in Canadian Textile Journal, 576, p. 30, March, 1940.

fabric, after scouring and stripping, to the boiling solution. Keep the fabric moving to prevent the result becoming patchy and then allow to immerse until the color is a medium brown. Remove the sample of fabric from the liquor, wash well with water and then with a 5 per cent acetic acid solution, and finally wash thoroughly to remove excess acid.

The fabric will then show any degraded cellulose as black spots or black streaks of yarn, which break under tension. The degree of degradation is the degree of blackness. There will always be a slight brown color on any non-degraded cellulose, it is only the black that shows degradation.

Uneven Dyeing around the Hank.—It is not uncommon to receive two dyed skeins from a customer with the complaint that although the two skeins were dyed together in the same dyebath and at the same time, they nevertheless came out in different shades. On holding the skeins together one will appear lighter than the other, but if both skeins are turned through 180° so that the other ends of the hanks are matched it is often found that the uneven dyeing effect is reversed, *i.e.*, the one which appeared darker at the other end is now lighter in shade. Obviously this is not a case of the two skeins being of different shades but there is an uneven dyeing effect around the circumference of the skeins. Actually, both skeins are affected in the same way, but the customer was evidently comparing the light end of one skein with the dark end of the other. This fault is sometimes referred to as "ending" and is more common when the skeins are turned by hand. It is usually caused by one or a combination of the following factors:

(*a*) Insufficient turning of the skeins in the dyebath, especially at the commencement of dyeing.

(*b*) Dipping the skeins into a bath containing its full amount of dyestuff and salt. It is better to commence dyeing with about half the amount of dyestuff and no salt in the bath, the remaining dyestuff and the salt being added in two or three portions at intervals during the dyeing process.

(*c*) Using mixture dyestuffs which have widely different dyeing speeds, or maximum affinities for the yarn at widely different temperatures. This can be better appreciated when it is remembered that the top of the skein, which is out of the dyebath, is colder than the remaining part which is submerged in the hot bath. The dyestuff with the greater affinity at high temperature will go on to the yarn readily in the submerged part of the skein and the dyestuff with maximum affinity at the lower temperature will go on to the colder part of the skein which is out of the dyebath. Of course, rapid turning, particularly at the commencement of dyeing or immediately after an addition of dyestuff or salt to the bath, will tend to prevent this from causing different shades around the circumference of the skein.

Where the facilities are available it is instructive to knit up small sections of the dyed hanks on a single feed. Any unevenness in dyeing around the skeins then shows up very distinctly in the form of streaks in the fabric. A dyer who wishes to determine the levelness of his hank-dyeing should make a test of this kind from time to time. Unevenness which is very difficult to see in the dyed skein itself shows up very distinctly in the knitted fabric.

Poor Penetration in Hank Dyeing.—We sometimes receive complaints of light patches inside the skeins and particularly around the lacings or tie-bands. In a case of this kind it would seem that the skeins have been dyed too rapidly with a mixture of dyestuffs having widely different dyeing speeds. The remarks just made, concerning the retarding of dyeing by holding back some of the dyestuff and salt to be put in later in two or three separate additions and at intervals, also apply to this type of fault.

It is reasonable to expect to dye hanks evenly in about ten minutes. Although from a winding point of view, it is desirable to keep the time of dyeing down to a minimum, it is more important to give a reasonable time for dyeing in order to ensure levelness.

(2) FAULTS FOR WHICH THE DYER IS NOT RESPONSIBLE

Weft bands in crepe fabrics have been particularly troublesome in the type of crepe fabrics known as "Gamsas," where the greater part of the creped filling is on the face of the cloth. The bands under consideration generally appear as "light-dyeing," are exactly parallel to the weft and occur at a change of pirn or at a knot in the twisted thread. Further, it has been found that they can be classified into one or the other of two broad groups, namely:

(*a*) Those which actually show a difference in the shade of the weft thread; and

(*b*) Those where there is no difference in the shade of the yarns.

This can be determined by carefully removing the threads from the cloth and winding them evenly side by side on a shade card.

Weft Bars Due to Yarn Shading.—The first group, where a difference in the shade of the yarn is found, can be subdivided into two further groups, viz., bars where the weft shows a normal pick length as compared with the darker dyeing or normal threads, and bars wherein the light-dyeing thread is shorter by an appreciable amount (usually from 1 per cent to 3 per cent) than the normal length of pick. Where the length of pick is normal and there is a difference in the shade of the weft threads, the fault can be due to a number of possible factors which cause modifications of the dyeing properties of the yarn. Among these can be the use of unsuitable tints or sizing materials resulting in oxidation of the yarn itself or in difficulties of removal from the yarn and requiring more severe treatment than the normal scouring process. This might be particularly troublesome where the goods have been stored in the greige for a considerable period of time.

(Continued on page 652)

PROCEEDINGS OF THE

American Association of Textile Chemists and Colorists

NOVEMBER 25, 1940

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CALENDAR OF COMING EVENTS

Meeting, Philadelphia Section, Penn Athletic Club, December 6, 1940.

Meeting, Southeastern Section, Atlanta Athletic Club, Atlanta, Ga., December 7th, 1940. Speakers: Dr. Karl Reiland, Pepperell Mfg. Co., Lindale, Ga.; L. L. Bamberger, Lanett Bleachery and Dye Works, Lanett, Ala., "Some Observations on the Tendering of Vat and Naphthol Dyed Army Duck on Total Exposure to Weathering."

Meeting, New York Section, Chemists' Club, New York, N. Y., December 13, 1940. Speaker: R. W. Jacoby, Ciba Company, Inc., "Trends in Printing and the Use of Resins in Finishing."

Snapped at the
Hotel Commodore
New York, N. Y.
During the Twentieth
ANNUAL MEETING
AND CONVENTION
October 18 and 19, 1940

Determination of

Wearing Qualities

by Air Flow Measurements*

ERWIN J. SAXL**

ABSTRACT:

By the use of air permeability tests in combination with abrasion tests, a new tool is given for determining progressively the degree of deterioration during the performance of the wear test. Determining the increasing degree of porosity of the fabric while it is abraded, makes it possible to follow its systematic breakdown without destruction of the sample. This not only increases the speed of the total test but simplifies the method and lowers the expenditure. It also permits to make the tests more precisely because all measurements are taken on one and the same specimen under investigation.

In addition, permeability tests taken as a criterion for the progress of fabric destruction make it possible for the first time to standardize on specifications which shall constitute the breakdown of the material to the point where its final perforation begins.

Actual operating instruments for testing air flow and wear are described and methods of standardization for the above tests are suggested.

INTRODUCTION

IT has been customary heretofore to compare the progress of wear of a fabric that is tested in an Abrasion Tester, or by any other type of wear test, either by visual comparison or by subjecting it to tensile strength tests. The method of personal subjective observation involves the human element of error. The progress of destruction by visual observation of the fabric can be determined subjectively with difficulty only as compared to another test. Moreover, an exact definition of the point of destruction where a hole begins to appear in the fabric, has not been defined with precision. Particularly in weaves of more open construction, or in knitted materials, the point where the fabric stops being just flimsy and starts to form an actual hole, is not sudden, but one of gradual transition. Visual observation is unsatisfactory therefore.

Equally, the investigation of the progress of the wear test with the aid of the tensile strength test has several disadvantages. This latter method involves the destruction of the tested sample in every instance. With the present methods for determining tensile strength say after 500 rubs, the strip is broken. Then it is necessary to start the test all over again for getting a strip that has been abraded 1,000 times, and so on. This method, therefore, is not only cumbersome and time consuming, but in addition subjected to indeterminate sources of inaccuracy because the comparisons of the progress of wear are made upon entirely different samples. A great number of tests, therefore, have to be made in order to reach the desired statistical degree of testing accuracy which in turn involves a considerable testing expenditure.

In view of this status of the matter, a new method has been developed by the writer which makes use of the progressive porousness of a fabric under conditions of wear. This is described in the following:

THE STANDARD ABRASION TESTER

The fabric to be tested is first abraded in an Abrasion Tester. In connection with this a number of different constructions exist. For a review of the previous references in this field, reference is made to the article of Professor Herbert J. Ball.[1]

The present construction is in accordance with the tentative A. S. T. M. specifications as follows:

Tentative Specifications for the Operation of the Standard Abrasion Tester

Number of strokes per minute..	96 double-rubs
Number of strokes per hour....	5760 double-rubs
Load upon abrading surface....	3½ lbs.
Load with which the sample to be abraded is stretched.....	6 lbs.
Abrasive material	No. 6 Army Canvas Duck

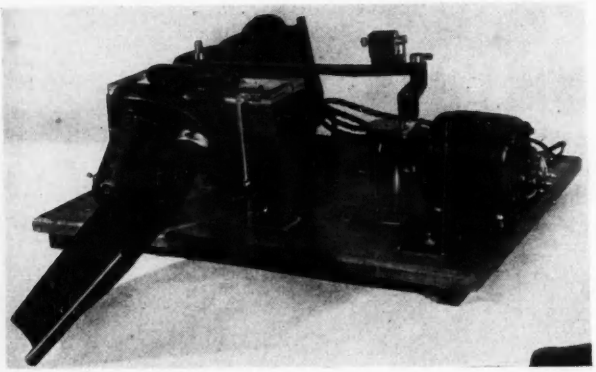
From a practical viewpoint of performance, the above specifications can be used in the operation of the standard Abrasion Tester specifically developed by the Saxl Instrument Co. for this purpose as follows. (See Figure 1):

The number of strokes per time unit is determined by the speed of the motor as shown on the right side of the picture. The motor windings are arranged in such a manner that by adjusting a rheostat (which may be either

*Presented at Symposium on Evaluation of the Properties of Finished Textiles, Annual Meeting, New York, N. Y., October 19, 1940.

**Saxl Instrument Co., Inc.

[1]Herbert J. Ball, Abrasion and Wear Testing, Rayon Textile Monthly, November, 1937.



(*Saxl Instrument Co.*)

Fig. 1—Abrasion Tester

of the rotating or of the slide-wire construction) in back of the motor, the speed of the latter can be varied.

An adjustment for the load upon the abrading surface can be made readily by placing more or less weight on the prong shown on top of the abrading arm. These exchangeable weights may be seen in their rest position upon the instrument board in the center background of the panel. In operation one or more of these circular weights are placed upon the arm. They are made with a hole that fits upon the prong provided for this purpose.

In preparing for a test, the right side of the test strip is clamped first. Either spring or screw clamps are provided for this purpose. Then a weight of 6 lbs. is attached with special clamps to the left end of the cloth, and the latter left hanging freely. Different sizes of weights may be used, thus providing for different stretch of the cloth sample. Under these conditions, the sample to be tested is stretched in the standard manner and may now also be clamped securely with the clamping device at the left side.

As to the abrading material attached to the arm, there still exists a difference of opinion. Some scientists prefer No. 6 Army Canvas Duck. This is used as the acting surface of the abrading arm. Other technicians, however, may prefer emery cloth, copper screening or other materials. Provisions have been made, therefore, to readily exchange such materials in the abrading arm, so that whosoever wants it may use his own preferred material.

Suction equipment is provided that properly cleans the surface of the specimen under test. In other words, during the operation of the Abrasion Tester, the acting surfaces are those of the tested specimen and of the abrading material only. Grit, particles of cloth and other material that may be removed during operation are taken away by the suction equipment. Upon special specifications, it is also possible to use a blowing equipment attached either to the moving arm or to the sides instead of the vacuum apparatus, or to use an attachment for chemical solutions to moisten the cloth, etc.

Under actual operation, the cloth is inserted and the motor switched on. Depending upn its disintegration the sample is removed, for example, every 500 or every 1000 double-rubs, and then reinserted. As it gets more flimsy under the protracted wear, it offers less resistance to a stream of air passing through it. This increase in porousness can be read directly on a separate instrument described in the following.

THE POROSITY TESTER

This new Porosity Tester is shown in Figure 2. Considerable simplicity has been attained by measuring with direct observation the stream of air that passes through the specimen under test. The current of air is produced by an air turbine built into the base of the instrument. The speed of this turbine and thus the current of air may be adjusted with a rotary rheostat shown at the right side of the picture. In this manner little air pressure may be used for examining thin fabrics such as silk stockings, while greater pressure is used for blowing air say through an overcoating material. The setting of the rheostat, and thus the current of air generated per unit of time can be reproduced at will by two methods:

1. By setting the pointer of the rheostat upon the calibrated dial.
2. The current of air produced for a given setting of the rheostat may be measured and reproduced.

In this latter instance the readings on the air flow meter may be made to coincide. In other words, at a given setting of the rheostat, and without cloth inserted, a certain amount of air will be driven into the indicating tube described hereafter. The amount of air passing through the tube can be read directly. If at any later time the same setting is desired, all that is necessary is to again adjust the rheostat to the point where the tube indicates the same amount of air passing through. In this manner, at any

Fig. 2—Air Flow Tester

(*Saxl Instrument Co.*)

later time, and at different climatic conditions, comparisons may be made that are in the absolute system.

The air stream coming from the turbine is now directed through a streamlined system onto the fabric which is inserted by a simple clamping device, forming the separating boundary between the air-generating and air-measuring system. On top of the specimen holder in inserted directly a glass tube of slightly conical shape. Within the glass tube is an air-float. This consists of a body of metal and/or other materials which has been designed correctly from an aerodynamic point of view.

When the stream of air that has been generated in the turbine partially trespasses the fabric and enters the tube, it sets up a column of air. If the lifting forces equal Gravity, a status of equilibrium is reached and the float rests freely in the air at a given height. Due to the slightly conical shape of the tube, the more air trespasses, the higher the float will then be driven. In this manner the position of the float indicates by direct reading the amount of air flowing through the tube.

It will be readily understood that the more air that trespasses the fabric sample under test, the more porous is the specimen. In other words, it may be assumed for an example that the original flow of air without sample was set at 10 cubic feet per minute. Now the specimen is inserted, but no other changes are made. In other words, the air turbine still rotates at the same speed.

On the calibration of the glass tube it can be seen, however, that now, after insertion of the specimen, the position of the float indicates by direct reading that only 2 cubic feet of air per minute is passing through the sample. This is $\frac{10}{2} = 5$. That is to say, only one-fifth of the original volume of air is permitted to trespass. In view of the fact that 10 cubic feet of air would be 100 per cent porosity, the 2 cubic feet of air now penetrating represent then only 20 per cent of the original value. The specimen is 20 per cent porous.

The initial setting of the air flow meter can be made, if desired, at any optional height. In this manner the percentage of porosity can be determined for a wide variety of fabrics and other materials. Equally, by using specimens of known porosity, direct comparisons from one specimen to the other can be made. Last but not least, by using specimens of known porosity, the range of the airflow meter may be extended into secondary ranges as necessary for specimens of extraordinarily low or high porosity.

While the new Porosity Tester as such opens up new fields of textile research and investigation, reference shall be made in this paper to one specific application only, that is to say, the use of this Air Flow Tester as an indicator for the progress of deterioration as produced by systematic wear and abrasion.

CORRELATION OF WEAR AND AIR PERMEABILITY

The longer a fabric is worn, the flimsier it gets. The flimsier a material, the less resistance does it offer against the passage of a current of air. *In this manner, air flow may be considered as a measure for wear.*

In actual practice, the fabric under investigation is first tested for porosity as is. Then it is abraded with the standard Abrasion Tester for a given number of strokes, say 500 double-rubs. Thereafter, its porosity is measured in the new Air Flow Tester, giving the effect of the abrasion. It is abraded again, its permeability is tested hereafter, and so on.

The progress of destruction, and the improvements in the method of investigation, become clear in comparing the subsequent figures, 3 and 4.

In Figure 3 the old method is shown which plots tensile

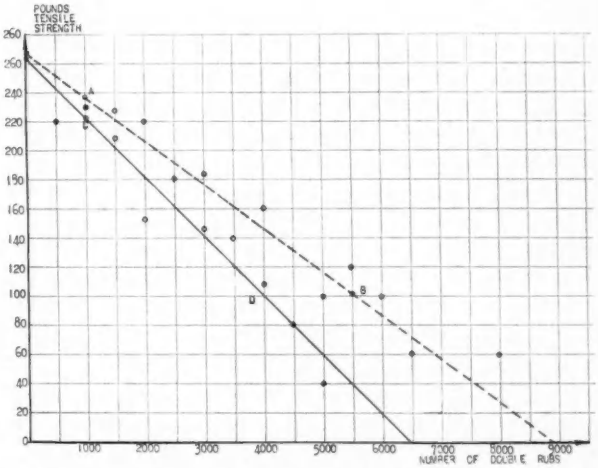


Fig. 3—Influence of the Number of Abrasive Strokes Upon the Tensile Strength

strength vs. number of abrasive strokes. This method is deficient in that it requires a great number of specimen, is time consuming, expensive, and misleading in certain instances. It can be seen directly that the spread of distribution between the individual measurements is such that a very considerable number of measurements have to be taken in order to describe correctly and with significant figures what actually happens in the fabric. There is an amount of danger in using this method because it does not lend itself readily to extrapolation. It is merely *assumed* that the destruction of the fabric follows a linear curve. (This relation has been found to be different as proven by measurements with the Porosity Tester.) Moreover, due to the wide divergence between the individual points, it is risky to measure only about two points, and then draw a line, because the spread of distribution is such that a final endpoint cannot be given with such a small number of points. On the very picture shown it can be seen that one set of measurements would produce an

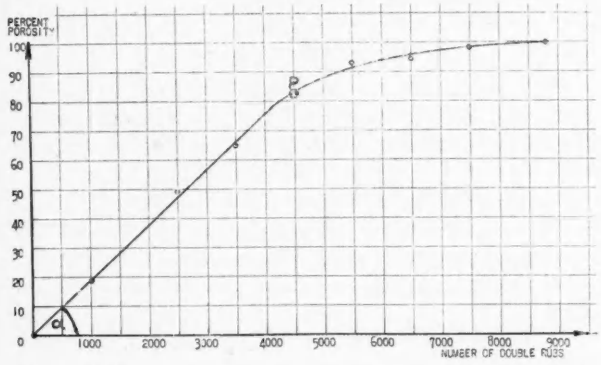


Fig. 4—Influence of the Number of Abrasion Strokes Upon the Air Flow.

apparent endpoint of 6500 double-rubs while the other group of measurements produces an endpoint of 8900 double-rubs. For this reason, and also because of practical considerations, the use of tensile strength measurement for the determination of wear is not to be advocated from a scientific and practical point of view.

On the other hand, correct results are obtained with the new Air Flow Tester, quickly and without undue expenditure. A look at Figure 4 will speak for itself. The percentage of permeability is plotted hereby as against the number of double-rubs. Not only do all points lie hereby practically within the curve, showing the accuracy and reliability of these practical measurements, but in addition the slant of the original part of the air flow curve can be determined without question. Thus a criterion is given for the initial wear of a textile material. The steeper this initial line, the greater the angle the more does the fabric under test resist wear.

There is, however, at least one more significant factor contained in Figure 4. It first shows that the notion held heretofore that a fabric disintegrates along a straight-line characteristic, simply does not agree with the actual facts found experimentally. What really takes place is that the fabric is destroyed linearly at the beginning only, while after a certain point is reached destruction progresses at an exponential rate. Comparable in a manner to the Yield Point when a fabric is stretched, there seems to occur a final yielding under conditions of wear. This is particularly pronounced in rayons and acetates, less sharply defined in cottons.

This deviation from the straight line characteristic has an experimental significance of great importance. The point where the exponential approach to 100 per cent air flow begins and the straight line characteristic starts to curve, may justly be defined as *the point where a hole in the fabric begins to appear.* (P). This new finding will be of particular practical as well as scientific value.

Influenced by subjective factors thus far it has remained quite uncertain at what point in the number of abrasive strokes it may be stated that there is actually the beginning of a hole. At these last abrasive strokes, an element of uncertainty remains with the observer. It really is difficult to state from plain observation, by eye, whether a hole has started already or whether the fabric is flimsy to the point where a hole is liable to occur at almost any one of the next strokes. The determination of the point of complete destruction as measured quantitatively with the Air Flow Tester is different. Here we have one and only one significant point. After this is trespassed it can be stated positively, that the rate of destruction of the fabric progresses more rapidly than before.

While in actual definition for purposes of standardization, the tangent of a given angle for instance, may be assumed to be the criterion for the start of the perforation in the textile material, for most practical purposes the plain observation of the graph will give the significant factors directly. It shows, first, by the angle α the wear resistance of the fabric. It gives, hereafter, by the position of the point P on the curve, an exact definition for the point in the test where a hole in the fabric begins to appear, thus settling an old dispute.

As stated before, by the use of the new Abrasion Tester as a criterion for the progress of abrasion and wear, the important measurements for wearing quality can be made not only more accurately but for a fraction of the time and expenditure required heretofore.

DISCUSSION

Mr. Kapelsohn: Dr. Saxl, I was interested in one thing particularly: On what types of fabrics have these porosity tests been made?

Dr. Saxl: These test measurements have been made on men's suitings.

Mr. Kapelsohn: Have you tried it on any other type of fabrics?

Dr. Saxl: Yes. I have tried it on thin materials for women's wear, also, but I have preferred to show these curves because they are of greater practical significance. Men's suiting has a more important style longevity than a woman's suit. The style life of a woman's dress is comparatively shorter, and therefore measurements on women's materials have not the same practical significance as those for us poor men who wear the same suit for three years.

Mr. Whittaker: Dr. Saxl, you said the same twenty fabrics had been tested by the usual breaking strength method and I wonder whether twenty fabrics with your porosity measurement would give curves that coincided, or would you get a distribution there?

Dr. Saxl: May I correct a minor misunderstanding perhaps? The curves shown were made on twenty specimens of one and the same fabric. They were not from different fabrics. They were one and the same material, twenty strips taken out at identical distances from the selvage, so that we can assume that the filling and the warp were stressed and inserted under identical conditions. This was one and the same cloth, but twenty different specimens from it.

Dr. Schwarz: May I make a suggestion? I am rapidly

developing a reputation as being a crank on terminology. For a number of years back we have been talking about the resistance to flow of air through fabrics, or, rather, the ease of flow of air through fabrics, as porosity. I wish we could forget the term in that connection and say permeability instead, because I can think of a break as being extremely porous and picking up a large amount of moisture and containing a lot of air which you can't blow in through the break.

There are many fabrics, men's wear in particular, overcoatings, suitings and the like, of felted and milled surfaces, maybe highly porous, and very nicely impermeable at the start of the test at least. I think the test is of very considerable interest and importance, but I think we should be following it by calling it by the right name. I am making this suggestion constructively in order that we don't get into difficulties later, because there will be methods shortly provided for measuring through porosity, which is the amount of air contained in the material in its volumetric relationship, and not a dynamic passage of air through.

Dr. Saxl: Dr. Schwarz, you certainly are right in this, and if you wish to term this tester a permeability tester, that suggestion is deeply appreciated.

Dr. Schwarz: I am telling it to the group, and when I make it to you I hope it won't inconvenience you too much because the machines are labeled.

Dr. Saxl: The only inconvenience I have is that I am afraid the average layman buying the instrument will have difficulty in pronouncing "permeability."

Dr. Schwarz: If you can think of an easier word, that is fine.

President Draves: As your curve slopes off, it seems that it really wears out less fast, doesn't it, on the sloping part of the curve?

Dr. Saxl: You will note on Figure 4 that the fabric has decomposed linearly up to 4500 rubs. Yes, you are right. It breaks off. I can only report the true status of the matter. These are experimental facts and have been found that way. But then in about another 4500 rubs you achieve complete destruction.

"Shrink-proofing" of Wool

with Bromine*

RALPH L. ERICSSON**

INTRODUCTION

PURELY from a consumer standpoint, the advantages of "shrink-proof" or, to use a better term, "shrink-resistant" wool fabrics are too obvious to require elaboration. The fact that such a fabric would be easier to wet finish than ordinary wool should also make such a material attractive to the textile industry in general, and to mill operators in particular. It remains, however, that the wool industry views with considerable skepticism any process claiming to produce a non-shrinkable finish on wool fabrics. A critical examination of the literature inevitably leads to the conclusion that this skepticism is justified in most instances. Few of the proposed methods of rendering wool non-shrinkable are free of faults which often outweigh the advantage to be obtained. Some of these processes require a considerable investment in equipment, others have high operating costs, excessively damage the wool fiber, produce insufficient non-shrinking effect or a wool difficult to dye properly.

The work to be described is an attempt to eliminate these disadvantages and while it is far from complete, sufficient information has been obtained to be promising.

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**Technical Service Division, Warner Chemical Company, New York, N. Y.

LITERATURE

In 1922[1] Trotman wrote that tensile strength and elasticity are not adversely affected when wool is properly treated with chlorine; when incorrectly treated these qualities suffer, the wool exhibits increased affinity for dyes and is more readily wetted down. Damage also continues if residual chlorine is incompletely removed. His experiments indicated that the epithelial scales disappeared and that the cortical cells were damaged most. Adams[2] concluded that absorption of dyes by chlorinated wool and normal wool are very similar, dyeings of the former are brighter possibly because of increased gloss or the presence of residual acid in the wool. In subsequent work Trotman found[3] that chlorine dissolves the amino compounds and converts the combined sulfur in the fiber into sulfuric acid; [4]chlorine is both absorbed and combined, and 6 per cent chlorine may be expelled from wool only on boiling and not by hydrogen peroxide; [5]that acid-free chlorine water produces practically no damage; that 0.1 per cent HCl greatly increases damage but that further additions are without effect; that NaCl exerts a protective action especially when 5 per cent of chlorine is used; that bromine reduces shrinkage with less structural damage than chlorine in equivalent amounts; [6]that bromine produces neither loss in tensile strength nor elasticity nor affects absorption of water and alkaline solutions, and that both brominated and

chlorinated wools readily absorb dyes from cold solutions.

Some methods have been the subject of a number of patents. Three of these[7, 8, 9] cover the use of various chloramines and a fourth[10] specifically describes the use of Chloramine T. A completely new departure from previous work is the basis of Hall's[11] patent. Hall claims that when wool, containing from 12 to 15 per cent moisture, is treated with a petroleum solvent solution of sulfuryl chloride, freed of solvent, washed and neutralized, its shrinking properties have been eliminated without damaging the fibers, no noticeable change in the epithelial scales having taken place. Fisher[12] has pointed out a number of discrepancies, if not in the process, at least in the published accounts of it. The main disadvantage seems to be a rather large capital investment for special equipment.

To be ideal, a shrink-proofing process for wool should (a) use present plant equipment with a minimum of alterations, (b) accomplish the desired result with little, if any, change in physical or chemical properties of the wool, (c) be applicable to yarn as well as piece goods, (d) be economical to apply and (e) require no complicated control nor highly trained personnel. A study of the above literature leads to the conclusion that bromination shows the greatest promise of fulfilling these requirements.

EXPERIMENTS ON PIECE GOODS

Our first experiments were undertaken on ladies' full-fashioned hose, knit from two ends of 1/40s worsted yarn. They were wet-out with a pine-oil soap and tetra-sodium pyrophosphate mixture according to standard procedures, hydro-extracted lightly and treated in 25 times their dry weight of aqueous bromine solution containing 0.38 per cent bromine (equivalent to 9.6 per cent, wool basis). Two facts were immediately observed: first, the hydro-extraction dried out the hose to the extent that complete wetting was delayed 15 or 20 seconds and second, bromine absorption was very rapid at 70° F. (the temperature of the experiment). 92 per cent was absorbed in 1½ minutes, 98.4 per cent in 3 minutes and 100 per cent in 5 minutes. After rinsing thoroughly, the hose were divided into three lots. One lot was set aside as a blank, one lot was treated with 2 per cent of sodium bisulfite, wool basis, liquor ratio 40:1 at 130° F. and the last was treated with 1½ per cent of ammonia, wool basis, liquor ratio 40:1 at 150° F.

The various lots were marked for identification and dyed, in the same dye bath, with a few hose not brominated. The brominated hose, regardless of after-treatment, proved to have a greatly increased affinity for the dye and left the untreated hose pale by comparison; those which had no after-treatment were very spotty and bled considerably on fulling: the after-treated hose were indistinguishable in color shade, were not quite so spotty and bled very little on fulling. None of the brominated hose shrunk in dyeing and only those not after-treated shrunk measurably on fulling. The untreated blank lost 7 per cent in dyeing and an additional 15 per cent in fulling. With the exception of one lot, all the fulling tests on the hose described in this paper were made by working them by hand in an alkaline soap solution at 130° F. for 10 minutes. The exception consisted of a lot which was fulled by machine for periods of 20 to 40 minutes. Even after 40 minutes of machine fulling, at about 140° F., no shrinkage was noticed by experienced boarders, and the only change seemed to be a slight increase in "loftiness." This particular lot did not appear to have been brominated uniformly and it was decided to try controlling the rate of absorption by controlling the rate of addition of the bromine.

In the next series, concentrated aqueous bromine solutions were fed slowly into water at room temperature in which previously wet-out hose were agitated with a paddle. Half of the hose were after-treated with bisulfite, and all were rinsed twice. Both bisulfited and not bisulfited hose were next treated with 2½ per cent of ammonia at 130° F. and after ½ hour in this solution were found to be neutral to litmus. Dyeing produced no shade differences in either lot of treated hose but both had apparently been made more alkaline than the blank since the latter dyed a deeper shade. This indicates the importance of a uniform degree of alkalinity or acidity if uniform dyeing is to be obtained and lends the first published confirmation of Adams'[2] observation that residual acidity possibly accounts for altered dyeing properties. This probably applies only to basic dyes. Again, shrinkage was negligible in both cases treated while the blank shrunk in foot size, as determined by experienced boarders, from 11 to 8½ and 17 per cent in length on fulling.

Another trial was made to determine the degree of non-shrinkability obtained in this hose with various percentages of bromine. The procedure followed was essentially the same as the previous experiment. The following table indicates the trend:

TABLE I
Hose Knit from Two Ends of 1/40s Worsted
Effect of Various Amounts of Bromine on Residual Shrinkage

% Br₂	*Per Cent Shrinkage During Dyeing*	*Fulling*
0.0	6.8	15.5
2.5	5.1	10.2
5.6	2.2	5.5
9.8	1.9	2.0

For articles such as knit hosiery, a total shrinkage of 5 per cent can be tolerated. It seems, therefore, that the most suitable amount of bromine producing satisfactory non-shrinkability with the least damage apparent by purely qualitative tests, is in the neighborhood of 5 to 6 per cent.

A series of laboratory brominations were run on skeins of so-called "fingering yarn," a woolen yarn of about 3/20s gauge. The purpose was to evaluate tensile strengths of yarn so treated. The process was essentially that employed in the previous cases. The yarn was neutralized with ammonia after treatment and aged at ordinary room con-

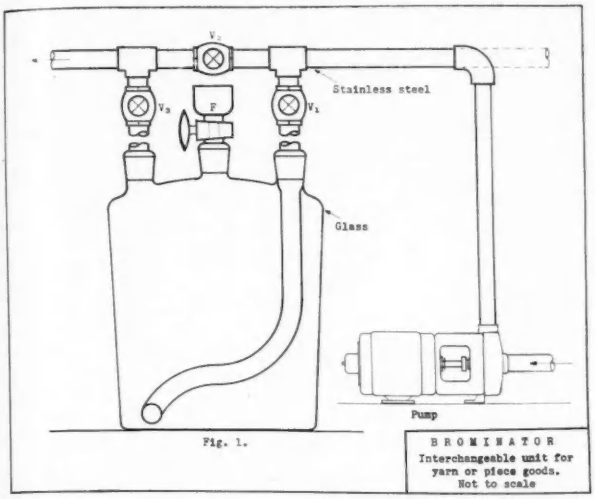

Fig. 1.

ditions for several days before determining tensile strength on a standard Scott machine. The following table is self-explanatory.

TABLE II
Tensile Strength and Elongation of Wool Yarn as Affected by Bromination

% Br_1	*Per Cent Elongation*	*Tensile Strength*
0.0	18.6	1.84
4.0	17.9	1.83
8.0	15.5	1.68

NOTE: Above results are averages of ten tests each.

EXPERIMENTS ON PACKAGED YARN

The most serious drawback to applying a shrink-resistant finish to piece goods is the limitation of the process to piece-dyed textiles. A few tests showed that bromination affects the shade of most colors, and therefore, to apply the process to fancy goods, it should be applied either to yarn or raw stock before dyeing. Since it is obviously impractical to ship 150 to 200 pounds of concentrated bromine water containing only about 3 per cent of bromine to treat each 100 pounds of wool, it was necessary to devise a "brominator" which would manufacture bromine water as needed from liquid bromine. By connecting this brominator directly to the water reservoir of the machine, such as a padder, a jig, a dye kettle or a Franklin type package unit, a means of controlling the rate of bromine absorption is obtained. Experience with other shrink-proofing processes indicates the difficulty of exercising a chemical control and it appears that a mechanical method has many advantages. A brominator has other desirable features: it almost completely eliminates fumes: it reduces the opportunity for corrosion of equipment because the wool absorbs the bromine practically as fast as it is dissolved and very low concentrations of bromine are present; and finally, handling of liquid bromine is reduced to a minimum.

Figure 1 is a sketch of the brominator. The pump is merely for circulating the water from the jig or dye kettle through the bottle containing the bromine. Package dyeing machines have sufficient pressure through the overflow pipe to eliminate the need for a pump. The brominator is filled, through funnel "F," with the amount of bromine necessary to treat the wool. The pump is started with valves V_1 and V_3 closed and valve V_2 open. When it is desired to brominate, valve V_3 is opened wide and the amount of bromine added is controlled by adjusting V_1 and V_2. A little experience with this machine soon indicated the proper valve settings and no trouble was encountered in duplicating rates of solution. The container in which the liquid bromine is dissolved is a Pyrex glass bottle. The tubes are also of Pyrex and standard taper glass joints make replacement of broken parts an easy matter. Since the bottle may be subject to an internal pressure of as much as 20 lbs./sq. in., the joints are clamped with devices not shown on the sketch. Rubber hose connects the bottle inlet and outlet to the proper valve.

A few experiments in a Franklin machine again indicated that the absorption of bromine is a very rapid process. So rapid, in fact, that the outside of the package was seriously over-brominated while the center did not receive enough to render it as completely non-shrinkable as was desired. Packages so treated were impossible to dye uniformly except with colors which exhaust very slowly. A Navy Blue formula consisting of approximately four parts of Wool Cyanone 3R, two parts of Wool Fast Blue BLA, one part of Alphazurine A, and two parts of sodium dichromate, selected because it exhausted quite rapidly and would thus be a good measure of uniformity, dyed the outside of the packages very dark but left a much lighter blue in the center.

Two methods of reducing the rate of bromine absorption were found to be (1) lowering the temperature and (2) lowering the pH. The former seemed most attractive and trials were run at 50° F. This temperature is probably the lowest that is practical and while the above dye proved that better results were obtained, the improvement was not sufficient. Tests with various acids in varying amounts showed that a strong acid like sulfuric acid is necessary to obtain and maintain the pH below 2.0. Laboratory experiments showed that best results were obtained below this point, since the pH at which an unbuffered bromination ends is due to the formation of hydrobromic acid and is in the neighborhood of 3.0, weak acids like acetic acid could not be expected to produce the desired result without using prohibitive amounts. Several repeat experiments with 5 per cent of sulfuric acid, 7 per cent of bromine, at 50° F. showed satisfactory dyeings and it was decided to move from the nine tube Franklin machine on which all the previous work had been done, to a 142 tube machine. This required a larger brominator and advantage was taken of the pressure differential across the overflow outlet pipe valve and there was no need for a separate pump. Water, by-passed from the overflow, passes into the brominator underneath the

level of the liquid bromine. It is broken up into small globules and sprayed up through the bromine. The concentrated bromine water then returns to the main overflow stream where it is partially diluted. Further dilution is affected in the stand-pipe and the amount of this solution which passes into the machine is governed by the amount overflowing from the package compartment.

The first experiment in the larger machine proved the advantages of the brominator and confirmed the preliminary calculations on which its construction was predicated. The operation was a success—but the wool dyed—unevenly. From all appearances, the bromine seemed not to have been applied uniformly and since the last small experiment had been successful and the only change was an increase in size, it seemed that this increase had introduced a new variable. Several packages were re-wound in such a manner that yarn in the center of the package during bromination was on the outside of the package during dyeing. In this case, instead of obtaining dyed packages with a light colored band in the middle, the light shade was found on the outside of the package. This test proved that the wool had not been evenly brominated. Three skeins taken from the outside, center and inside thirds of two packages were run for damage as indicated by alkali solubility according to the method of Harris and Smith.[13]

TABLE III
Alkali Solubility of Brominated Worsted Yarn No. 1

Location of Sample	*Per Cent Soluble*
Outside "A"	28.1
Outside "B"	28.2
Center "A"	14.1
Center "B"	12.9
Inside "A"	14.6
Inside "B"	14.6

It is obvious from the preceding table and the other evidence that the outside was damaged most and must, therefore, have received a higher concentration of bromine than any other part of the package.

A second experiment was run in an attempt to level out the treatment. In this trial, the rate of bromine addition was reduced by so setting the brominator valves that 30 minutes, instead of 20 minutes, were required to dissolve all the bromine. Alkali solubility analyses of the resulting product were as follows:

TABLE IV
Alkali Solubility of Brominated Worsted Yarn No. 2

Location of Sample	*Per Cent Soluble*
Outside "A"	17.1
Outside "B"	18.3
Center "A"	15.1
Center "B"	13.0
Inside "A"	36.6
Inside "B"	37.8

NOTE: The "A" and "B" designations in Tables III and IV refer merely to two tubes from which samples were obtained by "splitting" the packages in the proper place.

Obviously, no improvement was obtained. It is strange, however, that in the first case (Table III) the greatest damage is on the outside of the package whereas in the above case it is on the inside and is much greater in magnitude. The records of these two runs disclosed that during the first minute of bromination in the first case, fluid flow was from outside to inside of the package whereas during the first minute of bromination in the second case the reverse direction was employed. This may account for the location of the greatest damage in each case on the basis that previously damaged wool is more prone to further damage than undamaged wool. It is reasonable to expect that that portion of the package first subjected to the action of aqueous bromine, if it is somewhat damaged or shows "incipient" damage, will be most affected during the remainder of the treatment. The difference in magnitude may be attributed to the simple mathematics of the package, i.e., the outside quarter-inch of a four inch package contains over twice as much yarn as does the inside quarter-inch, and the amount of dilution of the bromine solution in the stand-pipe passing into the main body of the machine is not as great when the flow is from the inside of the package to the outside as it is when the flow is reversed. A more concentrated bromine solution is thus fed to the wool during the first minute when the flow is from inside to outside than is the case when the flow is reversed. As may be expected, neither lot of yarn dyed uniformly.

A critical inspection of the larger machine disclosed an interesting fact. The centrifugal pump was not running at its rated speed and fluid velocity through the package must have been much less than it was in the smaller unit. Since rate of absorption is partially dependent on the concentration, it stands to reason that there must have been an appreciable bromine concentration differential through the package. Theoretically, perfect bromination or uniform dyeing can only be obtained when there is a zero concentration differential in the fluid passing through the wool, but a concentration differential of zero restricts rate of absorption to zero as well. Actually, we can only retard rates of absorption and increase fluid velocity within limits and thereby keep concentration differentials at a minimum. When packaged wool is treated or dyed in such a manner that the center portion is less affected or lighter in shade than the inside and outside portions, we may feel certain that the rate of absorption is such that an appreciable concentration differential was obtained during the course of the treatment.

Assuming that the greatest possible fluid velocities are found in a new machine, the brominator was transferred to a 152-tube stainless-steel Franklin machine which had been in use about a month. Two experiments on this machine yielded the best results obtained thus far. The wool, after neutralizing, had an excellent appearance and handle. It dyed satisfactorily and half-hose knit from the dyed yarn were easy to pair-up for shade, did not have "bands" and no more than the normal number of seconds due to mechanical failure of the yarn were obtained.

A convincing demonstration of the non-shrinkable properties of this yarn was prepared by fulling a braid made

from a skein of treated yarn and a skein of untreated yarn. The treated yarn in the fulled braid still exhibited its thread-like identity and may be rather easily unravelled. The untreated yarn is a practically solid rope of felt in which a few threads may be seen but from which no thread may be drawn.

A property of as great importance as non-shrinkability is tensile strength. Three packages of undyed treated yarn and three of each of three lots of treated yarn dyed different colors were split by rewinding in such a manner that samples were obtained from the outside, center and inside of each package. Control samples consisted of undyed, untreated yarn and untreated yarn dyed the same three colors as the above. This yielded 48 samples of yarn and 10 tensile strength determinations were made on each sample with a Scott Tensile Strength tester. Table V is a recapitulation of the results obtained.

TABLE V

Tensile Strength and Elongation of Worsted Yarn as Affected by Bromination

Sample	*Color*	*Tensile Strength*	*Elongation*
Blank	None	0.23	10.9
Outside	None	0.24	12.3
Center	None	0.22	9.1
Inside	None	0.24	9.1
Blank	Maroon	0.21	6.9
Outside	Maroon	0.21	7.0
Center	Maroon	0.20	7.6
Inside	Maroon	0.16	6.0
Blank	Blue	0.17	5.7
Outside	Blue	0.19	5.2
Center	Blue	0.19	6.1
Inside	Blue	0.16	5.3
Blank	Brown	0.18	5.8
Outside	Brown	0.19	6.4
Center	Brown	0.22	7.1
Inside	Brown	0.17	5.5

NOTE: "Blank" samples were not brominated.

An inspection of Table V shows that there is no significant change in tensile strength on brominating 1/40s worsted according to the above procedure. There is a slight reduction in elasticity as indicated by the change in elongation. The most startling part of this table is the indication that a significant reduction in tensile strength and a large loss in elasticity are obtained on dyeing whether the yarn has been brominated or not. This is probably due to the boiling necessary to exhaust the dye.

DISCUSSION AND CONCLUSIONS

This paper is a preliminary report on some of the work done and while no hard and fast rules may yet be laid down, a number of indications have been obtained.

1. Perhaps of primary importance is the necessity of neutralizing all the acid absorbed by the wool particularly when basic dyes are employed. The literature states, and we found it to be true in this work, that mere rinsing will not remove these mineral acids and neutralization must be employed. Of course, this would not be so important a factor with acid colors and certain other classes of dyes.

2. The uniform application of bromine to wool piece goods depends on the maintenance of low temperatures and low bromine concentrations. The apparatus which has been developed serves to apply the bromine uniformly under accurate mechanical control and eliminates most of the fume nuisance so objectionable when other means of application were tried.

3. The uniform application of bromine to packaged wool yarn is dependent upon temperature and pH control of the solution and maintenance of low concentration differentials through the package. Best results have been obtained with the described apparatus when the pH was held below 2, the temperature below 60° F. and at high fluid velocities.

4. By means of the apparatus described 1/40s worsted yarn has been treated successfully with 7 per cent of bromine, dyed uniformly and knit into hose with no more than the normal number of seconds. These hose have resisted a 40 minute fulling with no significant shrinkage and with insufficient bleeding to affect the shade. The "handle" of these fulled hose was excellent and slightly loftier than unfulled hose.

5. Finally, the simplicity of operation and control of this process of rendering wool shrink resistant require a minimum of change in mill practices. All additions of reagents are on a weight-of-the-wool basis and are practically independent of the amount of water present. The operation is performed in dyeing equipment after the material has been prepared for dyeing but before dyeing is started. About one hour is required for the complete treatment.

ACKNOWLEDGMENTS

The interest and encouragement of R. W. Sulloway and R. L. Thompson of the Sulloway Hosiery Mills, Franklin, New Hampshire, in extending the facilities of their mill are gratefully acknowledged. The cooperation of Leo Van Koert and Robert Stanley, of this firm, was invaluable and their experience with package and piece dyeing simplified many of the problems that were encountered.

Patents have been applied for on the process and apparatus described in this paper.

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DISCUSSION

Mr. Goodings: I would like to ask Mr. Ericsson if he has not found a very pronounced influence of the degree of dilution of his bromine; that is to say, if you could obtain on a shrinkability with 5 per cent of bromine, we

will say, a ratio of ten to one, if you had that very much more diluted, you would then not get unshrinkability.

It has been our experience with chlorine that you can get unshrinkability with, say, 1 to 2 per cent of chlorine on the weight of the goods, provided that your concentration is high, but if you increase your dilution then you can't get unshrinkability even with, say, the application of 10 or even 12 per cent. There seems to be some secondary reaction which is not related to reduction of unshrinkability.

Mr. Ericsson: Our experience with chlorine has been limited in this application. We were discouraged by the literature, and encouraged by the literature to go into bromine.

We worked with extremely dilute solutions, as you probably presume from this paper. The observation that 92 per cent disappeared in the first minute and a half, that 80 per cent of what was left disappeared in the next minute and a half, and that the remaining per cent and a half took almost two minutes to disappear led us to the belief that we should stay in that range; and the only way we could stay in that range was by feeding the bromine in slowly from outside the sphere of reaction, with a brominator.

There are many similarities, chemically, between chlorine and bromine, but those similarities don't carry over in hypochloride-hypobromide reactions, for instance. Your observation is probably perfectly correct on chlorine, but is at variance with our experience in bromine. We found that the more dilute the solution was, the better our chance of control was, because our rate of reaction was much slower, and we had to have a slow rate of reaction to drive the wool through an inch to an inch and a half of yarn that you find on a Franklin machine.

Mr. Eavenson: Does this brominated wool exert any harmful effect on the skin, bringing about dermatitis, etc.?

Mr. Ericsson: That is an interesting question, and it hasn't been determined scientifically by us yet. Many dozens of these hose are being worn by employees of the company and friends, and so far we haven't run across any irritation. I have worn many of them myself for long periods of time.

Mr. Sedgewick: You speak of the bromine process as regards yarn. Could it be done on the Franklin process raw stock machine?

Mr. Ericsson: We haven't done any work on raw stock. One of the main reasons is that you have to work with rather large percentages. We have made very few tests on raw stock in the laboratory and haven't had any great success. As you can see, the principal part of our work has been with the worsted yarn. We believe that a worsted yarn does not have the intrinsic ability to shrink as much as a woolen yarn, for example, and raw stock, naturally, would shrink much more. We haven't done any work on raw stock yet.

Chairman Thompson: That completes the time that we have allotted for this paper. Thank you, Mr. Ericsson.

The Dyeing of
Nylon Fibers
with Acid Colors*

P. H. STOTT

AT the Annual Meeting of the American Association of Textile Chemists and Colorists held in Boston, September 15 and 16, 1939, a paper was presented on "The Dyeing of Nylon Fibers—A Preliminary Survey." This paper was published in the Proceedings of the Association in the AMERICAN DYESTUFF REPORTER of October 2, 1939, and contained experimental data of the dyeing properties of nylon with various classes of dyestuffs. Further research performed in the Technical Laboratory, Dyestuffs Division, E. I. du Pont de Nemours & Co., Inc., during the past year, has revealed more interesting data, particularly from the standpoint of dyeing nylon with acid colors, and the purpose of this paper is to communicate the results of this experimental work to the Association.

The generic name nylon refers to materials defined as synthetic polymeric amides with a protein-like chemical structure and therefore more closely related to silk and wool than to cellulosic fibers. Early observations of the behavior of nylon to dyestuffs indicated that the fiber possessed very low affinity generally for direct cotton, sulfur and vat colors in terms of the affinity of cellulosic fibers for these classes of dyestuffs. On the other hand

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**E. I. du Pont de Nemours & Co., Inc.

colors normally used for dyeing protein fibers such as silk and wool were absorbed by nylon. In addition, colors used for dyeing cellulose acetate showed very good affinity for nylon and as these colors also exhibit some affinity for protein fibers the analogy drawn between the latter and nylon was very logical. Similarly, cellulose acetate, being more plastic in nature than other cellulosic fibers is dyed readily by highly dispersed suspensions of dyestuffs which are relatively insoluble in water and it is possible, therefore, to draw an analogy between nylon and cellulose acetate insofar as behavior towards such dispersions is concerned. These characteristics of the dyeing properties of nylon were mentioned in the author's paper previously referred to and it was recognized at that time that the affinity of nylon for acid colors was in most cases lower than that of pure silk and wool for the same dyestuffs and that the saturation of the fiber would play a part in determining suitable individual colors and combinations of colors for practical dyeing.

It was also recognized that the fiber was relatively selective in its behavior, especially in making dyeings with a combination of two or more colors, and that this selectivity made it difficult, if not impossible, to make shade corrections by additions of dyestuff to a dyebath not completely exhausted. It also appeared that the phenomenon of colors "boiling on and off" which is more or less common to dyestuff behavior on cellulosic and animal fibers did not occur to nearly the same degree in dyeing nylon and consequently the difficulty of obtaining level dyeings was considerably increased.

In order to obtain as clear a picture as possible of the behavior of acid colors to nylon, recognizing that in them greater possibilities of increased fastness, especially to light and washing, existed than is the case with acetate colors, it seemed necessary to evaluate each acid color which had reasonable affinity for nylon and to try to establish a basis on which they could be dyed satisfactorily in combination.

We have reported previously (A. D. R., October 2, 1939) on the affinity of a complete range of acid colors for nylon dyed from both neutral and acetic acid dyebaths. From this range were selected those dyestuffs which had reasonably good affinity from a neutral bath and these were made the subject of further investigation. We are now able to classify these colors on the basis of:

1. Saturation Point from a dyebath containing 5 per cent acetic acid and 40 per cent Glauber's salt crystals.
2. Speed of Exhaust from a similar dyebath.
3. Relative affinity from a neutral bath in terms of saturation points.

The definition of the above terms are as follows:

1. SATURATION POINT

The percentage of color absorbed by nylon under the dyeing conditions stated above, determined at the point where the dyestuff ceases to be absorbed in the same relation as the quantity present in the dyebath. For example, Du Pont Anthraquinone Blue SKY in preliminary tests indicated a saturation point of between 2.5 per cent and 3.5 per cent. Dyeings were then prepared using 5 per cent acetic acid and 40 per cent Glauber's salt for one hour at 190° F. in strengths from 2.5 per cent to 3.5 per cent in gradations of 0.25 per cent. The color left in the exhaust was then picked up on a skein of pure silk and attached to the original dyeing in each case. Observation of results showed about as follows:

% Dyeing	*Gradations of Original Dyeing*	*Exhaust*
2.5	.....	Very slight color
2.75	.....Normal increase	Slight color
3.00	.....Normal increase	Appreciable color
3.25	.....Very slight increase	Considerable color
3.5	.....No increase	Very much color

Considering the expected gradation (or increase in depth) of the original dyeing when compared to the one immediately preceding it and taking into consideration the amount of color left in the exhaust a saturation point of approximately 3 per cent was arrived at for Du Pont Anthraquinone Blue SKY. It is appreciated that this figure is not accurate to probably more than plus or minus 10 per cent and that it obviously relates only to the current standard of each dyestuff evaluated.

2. SPEED OF EXHAUST

On the premise that most colors are used in combination with others and in view of the fact that the saturation point has a definite bearing on practical as well as experimental dyeings, it was considered that speed of exhaust determined at a figure under the actual saturation point would be most valuable. It was decided that these figures should be on the basis of one-half the saturation point. For example in the case of Du Pont Anthraquinone Blue SKY (saturation point 3 per cent) a dyebath containing 1½ per cent color, 40 per cent Glauber's salt and 5 per cent acetic acid was heated to 190° F. and five nylon skeins of 5 grams each entered successively and each dyed for five minutes. The amount of color on each skein was then evaluated in terms of an original dyeing of 1½ per cent. In the dyestuff under discussion it was found that 80 per cent of the color exhausted in the first five minutes; 20 per cent in the second five minutes and the remaining skeins were white. A classification of speed of exhaust was made on each color on the following basis:

Very rapid—90-100 per cent first five minutes
Rapid—80-89 per cent first five minutes
Medium—70-79 per cent first five minutes
Slow—55-69 per cent first five minutes

3. RELATIVE AFFINITY FROM NEUTRAL BATH

This figure expresses the amount of color absorbed by nylon fiber from a neutral bath containing 40 per cent Glauber's salt in 1 hour at 190° F. using as a basis for the original percentage of dyestuff, one-half the saturation point. For example, Du Pont Anthraquinone Blue SKY (saturation point 3 per cent) was dyed at 1½ per cent

under the conditions stated and the amount of dye absorbed measured by making a series of dyeings from an acetic acid (5 per cent) and Glauber's salt (40 per cent) bath to determine the equivalent of color absorbed from the neutral dyeing. In this case a 0.825 per cent dyeing from an acid bath was equal in strength to the color absorbed from a 1½ per cent dyeing from a neutral bath which gives a percentage figure of 55 per cent. As will be explained later this neutral dyeing index seems to be of value in determining suitable combinations of colors from a standpoint of uniform dyeing properties.

The classification of the colors tested is given herewith in tabular form separated into groups on the basis of speed of exhaust.

Color	Saturation Point	Neutral Affinity
1. *Slow*		
Carbolan Violet 2RS	1.75	45
Du Pont Anthraquinone Violet 3R	2.0	55
Du Pont Anthraquinone Rubine R Conc.	2.25	25
Du Pont Anthraquinone Blue SWB	2.5	20
Pontacyl Fast Blue GR Conc.	4.0	55
Du Pont Anthraquinone Green GN	2.0	50
Pontacyl Fast Black BBN	4.0	65
Pontacyl Fast Black N2B	3.5	35
2. *Medium*		
*Carbolan Yellow 3GS	2.0	35
Du Pont Milling Yellow G	3.0	45
Du Pont Milling Yellow R Conc.	1.25	45
Du Pont Quinoline Yellow Conc.	1.0	20
Du Pont Milling Orange R	1.75	50
Du Pont Silk Orange R Conc.	2.5	25
Du Pont Resorcin Brown 5G	3.5	40
Du Pont Silk Brown R	2.0	35
*Carbolan Crimson BS	1.75	15
Du Pont Milling Red 3B Conc.	1.0	45
Du Pont Milling Red R Conc.	1.0	45
Carbolan Blue BS	2.25	55
Carbolan Blue RS	1.5	45
Du Pont Anthraquinone Blue RXO	2.0	55
Du Pont Anthraquinone Iris R	2.5	35
Pontacyl Fast Blue GB	4.5	70
Pontacyl Fast Blue 5R	3.0	65
Pontacyl Wool Blue BL	3.0	40
3. *Rapid*		
Du Pont Azo Yellow Conc.	2.0	55
Du Pont Neutral Brown 2RS	2.5	65
Pontacyl Fast Brown CGS (Pat.)	3.0	50
Du Pont Milling Red SWB	1.5	50
Du Pont Milling Red SWG	1.5	50
Pontacyl Fast Red AS	1.5	65
Pontacyl Ruby PL Conc.	5.0	52
Pontacyl Scarlet 2G	2.5	45
Du Pont Silk Red BW Conc.	2.5	75
Du Pont Anthraquinone Blue AB	3.5	40
Du Pont Anthraquinone Blue SKY	3.0	55
Pontacyl Wool Blue GL	3.5	45
4. *Very Rapid*		
Du Pont Metanil Yellow Conc.	1.25	50
Du Pont Milling Yellow 5G Conc.	2.75	45
Du Pont Neutral Yellow GS	6.0	90
Du Pont Orange RO	1.0	30
Du Pont Anthraquinone Blue SWF	3.5	75

*These colors are in between "Slow" and "Medium."

DISCUSSION OF DATA

From the foregoing it is obvious that any dyestuff suitable at all for dyeing nylon can be used as a *self-color* up to the limit of its saturation point. This at once makes available a wide range of shades of varying degrees of fastness to light, washing and other destructive influences and the selection of any dyestuff will naturally be made on the basis of these fastness requirements. Good dyeing technique dictates, however, that the colors used be capable of dyeing in combination with each other and this is one of the major difficulties encountered in dyeing nylon with acid colors. The selective nature of the fiber towards individual dyestuffs as regards absorption (Saturation Point); speed of exhaust and to a lesser extent affinity from a neutral bath play a part in determining

1. A suitable combination from a standpoint of uniform dyeing.
2. The limit of depth of shade to which such a combination can be dyed.
3. The possibility of feeding color to match a given shade.

It seems possible from the tables to select more or less accurately on a mathematical basis those colors which fulfill the above requirements. The first approach to this is to select colors whose saturation point, speed of exhaust, and neutral affinity coincide as closely as possible. In doing this it must be remembered that a color with a high saturation point will exclude a second color with a lower saturation point when used in combination with it to such a degree that an equilibrium between the dyestuff content of the dyebath and the actual color absorbed by the fiber is not maintained during the dyeing operation. It appears that this equilibrium can only be maintained reasonably well if the *total* dyestuff content of the bath is no greater than the saturation point of the dyestuff with the *lowest* saturation point.

This phenomenon can best be illustrated by a few samples taking green shades made by using blue and yellow in combination. In all examples the blue is the same, namely Du Pont Anthraquinone Blue SKY. Referring to the tables the following colors and data are selected:

	S.P.	Exh. Speed	N.A.
A. Du Pont Anthraquinone Blue SKY	3	R	55
B. Du Pont Quinoline Yellow Conc.	1	M	20
C. Du Pont Milling Yellow R Conc.	1.25	M	45
D. Du Pont Milling Yellow 5G Conc.	2.75	V.R.	45
E. Du Pont Neutral Yellow GS	6	V.R.	90

Interpreting the theory expressed above it should be possible to dye the various combinations and still maintain equilibrium in the following total concentrations only:

A + B	1%	A + D	2.75%
A + C	1.25%	A + E	3.0%

Further it is to be expected that various permutations of the components in the same mixture can be made and still maintain a reasonable equilibrium so long as the total color does not exceed the figure given. It is also expected that relatively clear exhaust will be obtained from such combinations so long as the total color does not exceed the saturation point of the dyestuff with the lower saturation point.

Example I

Du Pont Anthraquinone Blue SKY A. (Sat. Pt. 3%)
Du Pont Quinoline Yellow Conc. B. (Sat. Pt. 1%)

Dyeings Made		*Shade of*	*Depth of Exhaust*	*Shade of Exhaust*
A	*B*	*Dyeing*	*Dyeing*	*Dyeing*
0.25	0.25	Yellow Green	White	.....
*0.5	0.5	Yellow Green	Trace color	Yellow
0.75	0.75	Bluish Green	Much color	Yellow
1.0	1.0	Very blue green	Very much color	Yellow

Example II

Substitute Du Pont Milling Yellow R Conc. C. (Sat. Pt. 1.25%)

A	*C*			
			Trace color	.....
*0.625	0.625	Medium green	Appr. color	Yellow
1.0	1.0	Bluish Green	Much color	Greenish yellow
1.25	1.25	Blue Green	Very much color	Green yellow
2.0	2.0	Dull greenish blue		

Example III

Substitute Du Pont Milling Yellow 5G Conc. D. (Sat. Pt. 2.75%)

Dyeings Made		*Shade of*	*Depth of Exhaust*	*Shade of Exhaust*
A	*D*	*Dyeing*	*Dyeing*	*Dyeing*
1	1	Blue green	Trace color	.....
*1.25	1.25	Blue green	Noticeable color	Blue green
1.50	1.50	Blue green	Appre. color	Blue green
2.0	2.0	Blue green	Much color	Blue green

Example IV

Substitute Du Pont Neutral Yellow GS E. (Sat. Pt. 6%)

A	*E*			
			Trace color	.....
1	1	Yellow green	Noticeable color	Pale blue
*1.5	1.5	Yellow green	Considerable	Blue
2.0	2.0	Very yellow green	color Much color	Blue
3.0	3.0	Very yellow green		

*Approximate saturation point.

In interpreting the above data it is obvious that any combination which maintains its shade when dyed in various strengths, and shows an exhaust dyeing also uniform in shade and of the same tone as the original dyeing, will be a more satisfactory dyeing combination than one which shows variations in these respects. In the foregoing examples, No. 3 exhibits these characteristics. Example No. 1 very definitely indicates that Du Pont Quinoline Yellow Conc. is not absorbed in dyeings containing 1 per cent or more total color. Example No. 2 illustrates the same phenomenon using Du Pont Milling Yellow R Conc. at 1.25 per cent total color. Example No. 4 illustrates that Du Pont Anthraquinone Blue SKY which is common to all examples is not absorbed uniformly when used in combination with a yellow of a higher saturation point, namely Du Pont Neutral Yellow GS (Sat. Pt. 6 per cent).

It is possible to draw the following conclusions from these data:

1. The saturation point of a combination of dyestuffs is approximately equal to that of the component with the lower saturation point.
2. That color ceases to be absorbed in relation to dyebath content in percentages over the above saturation point.
3. Dyestuffs having the same or closely related saturation points provide the most satisfactory combinations.

EFFECT OF EXHAUST SPEED

In the dyeing of all textile fibers it is advisable to select colors which have approximately the same speed of exhaust. Due to the selective nature of nylon fiber for acid dyestuffs such precaution is naturally emphasized. Experimental work indicates that it is possible to use colors in combination which are classified in adjacent groups from the standpoint of speed of exhaust provided that the colors have closely related saturation points. For example Du Pont Anthraquinone Blue SKY (rapid) and Du Pont Milling Yellow G (medium) both with saturation points of 3 per cent dye reasonably well in combination. Du Pont Anthraquinone Blue SWF (very rapid, saturation point 3.5 per cent) and Du Pont Milling Yellow G on the other hand tend to produce uneven dyeings when used in combination, and the same statement is true of combinations of Du Pont Anthraquinone Blue SKY and Carbolan Yellow 3GS which are classified as rapid and medium-slow respectively. One obvious conclusion can be drawn from these data. To use in combination those colors whose exhaust speeds are as nearly comparable as possible.

EFFECT OF AFFINITY FROM A NEUTRAL BATH

Our work on this is not yet complete and about the only conclusion we can draw at present is that a color with a high neutral dyeing index when dyed in combination with one of a low neutral dyeing index does not produce evenly penetrated and level dyeings. It is altogether probable that a relation exists between neutral affinity and affinity at low temperatures from an acid dyebath. If this is true there is little doubt that a dyestuff with a high natural dyeing index would be absorbed during the heating up of the dyebath in preference to a dyestuff with a low neutral dyeing index. The fact that most acid colors do not "boil on and off" when dyed on nylon will naturally militate against ultimate levelling of such a combination. We believe, therefore, that in selecting a combination of dyestuffs the neutral affinity of its components should be synchronized as closely as possible, although this is probably not a major consideration.

Final conclusions on the selection of what might be expected to produce a satisfactory dyeing combination of acid colors on nylon can now be stated as follows: The colors selected should be as nearly comparable as possible on the basis of

1. Saturation Point
2. Speed of Exhaust
3. Neutral Affinity

Reference to the tables will indicate these colors and on this mathematical basis examples are given herewith. A combination of three colors to produce a series of shades of brown is desired. Selection is made from the tables as follows:

Example 1

	Saturation Point	*Exhaust*	*Neutral Affinity*
Du Pont Anthraquinone Blue SKY...	3	R	55
Du Pont Milling Yellow 5G Conc.....	2.75	VR	45
Pontacyl Scarlet 2G	2.5	R	45

This combination can be dyed to a total color percentage of about 2.5 per cent and practically complete exhaustion

obtained. The component colors can be varied in any proportion within the approximate 2.5 per cent total and remain in true colorimetric relation. If this combination is dyed in higher total percentage than 2.5 per cent the dyebath will not be completely exhausted and the blue and yellow elements will predominate over the red element somewhat in the original dyeing but on the whole the above combination is satisfactory.

Example 2

	Saturation Point	*Exhaust*	*Neutral Affinity*
Pontacyl Fast Blue 5R.....	3	M	65
Du Pont Milling Yellow G	3	M	45
Du Pont Milling Red SWG	1.5	R	50

This combination can be dyed to a total color percentage of about 1.5 per cent and the colors varied among themselves as in the above example. However, the higher saturation point of the Blue 5R combined with greater neutral affinity does not give a good dyeing combination from the standpoint of level dyeing as the blue is attracted more quickly than the yellow and red due to more rapid absorption during the heating up process of the dyebath. This combination is not satisfactory.

As a result of this investigation we can only see somewhat limited possibilities of successfully dyeing nylon with acid dyestuffs from a practical dyehouse point of view, and for the following reasons:

1. Previous observations show that physical variations in nylon are emphasized by acid colors for the most part.

2. The care required in the selection of colors which dye satisfactorily *in combination* for the reasons given in this report. Obviously the use of self colors is limited only to individual affinity.

3. Difficulty of feeding colors for the purpose of shade matching in full shades caused by selective affinity of the yarn (saturation point) and the fact that acid colors do not "boil on and off" to any extent.

4. The desirability of the use of acid in the dyebath. Dyers of fabrics made of silk and related fibers are generally accustomed to processing in neutral baths buffered with soap and similar products. The use of acid is not a major objection in yarn dyeing but until we have a clearer picture of the types of fabrics for which nylon has a potential value, the opinion is expressed that dyeing from acid baths may prove to be somewhat undesirable.

5. The restrictions imposed under heading No. 2 above are reflected in the choice of combinations having a high degree of fastness. For example the combination of Anthraquinone Blue SKY, Du Pont Milling Yellow 5G Conc. and Pontacyl Scarlet 2G is apparently satisfactory from a dyeing standpoint but is deficient in light fastness owing to the comparatively poor fastness of Pontacyl Scarlet 2G.

6. A sharp drop in fastness to hot moist pressing is apparent in most cases at the saturation point and the same statement is also true to a somewhat lesser extent in regard to fastness to washing at 160° F.

7. Microscopic examination of cross-sections of nylon filaments indicate that most acid colors do not penetrate throughout the filaments but are present in much greater concentration on the outside surface. Similar examination of acetate colors shows uniform penetration throughout the filaments with the exception of developed black which shows excellent dyestuff penetration but only superficial development of the coupled dyestuff on the surface of the filaments.

If it is possible to draw any final major conclusion from the experimental data presented herewith it would appear to indicate that the protein-like chemical structure of the current production of nylon is less influential in the behavior of the fiber to water soluble acid colors than are its combined physical and chemical structure in its relation to highly dispersed suspensions of water insoluble colors.

Unemployment Register

Persons who are listed in the unemployment register should notify the secretary or the American Dyestuff Reporter IMMEDIATELY when they obtain employment.

OBITUARY

E. MARTIN LINDGREN

E. MARTIN LINDGREN, secretary and treasurer of the Carbic Color & Chemical Co., Inc., died suddenly on November 7th at his home in White Plains, N. Y. He had been at his office previously in the day.

E. MARTIN LINDGREN

He was born in Brooklyn, N. Y., on July 3rd, 1869, and joined Carbic in 1893. He was elected secretary and treasurer in 1916 and held this position until his death. He was also a member of the board of directors during this period.

Mr. Lindgren was a member of the Tamarack Country Club, the Pioneer Bowling Club of Brooklyn and the B G A Bowling Club of White Plains. His wife, Gertrude Taylor, died in 1938.

• GENERAL RELEASE

General Dyestuff Corp., 435 Hudson St., New York City, has recently released a circular describing the following product:

Benzo Viscose Blue G S Conc.—a direct color recommended by the manufacturers for use on cotton and, in particular, on rayon. It is said to be distinguished by an attractive bright shade, by comparatively good wash fastness and by good dischargeability. Aftertreatment with formaldehyde does not alter the shade and causes a slight improvement in wash fastness. Aftertreatment with copper sulfate renders the dyeings slightly greener and duller and improves their fastness to light considerably. It stains acetate rayon effects slightly and silk effects heavily. On union goods at the boil, the wool is dyed somewhat lighter than the vegetable fibers, but approximately to the same shade. At 150° F. the wool is stained comparatively little, and it can be kept practically unstained at this temperature with the aid of Katanol W B Conc.—Circular G-205.

• LAUNDRY TESTING SERVICE

A significant development in textile testing was disclosed this week with the announcement that the American Institute of Laundering has completed arrangements with the Tennessee Eastman Corporation for a laundry testing and possible approval service of fabrics made from Eastman rayon yarn. Of particular importance is the statement that the Eastman-laundry program intends to work along radically different lines from all present rayon testing plans, in that the project will not end with fabrics, but will carry through to garments; that the consumer will receive from the American Institute of Laundering a warranty as to the serviceability of the entire garment, including buttons, thread and other trim, and sizing standards as well as fabrics.

It was learned from an Institute spokesman that the laundry industry has never entered the rayon field because it has always considered garments rather than fabrics to be the important item to the consumer, and thus found its testing policies incompatible with rayon merchandising.

It has been learned that Tennessee Eastman Corporation in this testing service is most interested in its crimped acetate staple Teca as a stabilizing agent for spun rayon fabrics. Washable fabrics made of filament will be brought into the program, but the present emphasis is to be placed on Teca blends of spun rayon. To date, the Institute has been able to give its Laundry-Tested and Approved Seal to blends of 50 per cent Teca and 50 per cent Viscose staple which, through careful finishing, can be so pre-shrunk as to meet the Institute's standards of 2 per cent shrinkage under machine pressing and 2 per cent stretch under hand ironing. It will be noted here that these standards are identical with those used by the Institute for pre-shrunk cotton woven goods. The program is intended to embrace blends of Teca with cotton and other fibers besides Viscose staple.

Weavers

The program will start with the weaver. Any weaver may submit his experimental constructions in a finished state to determine if they are satisfactorily launderable fabrics. If so, the weaving mill and its satisfactory constructions will be placed into the program.

Finishers

Since built-in quality with rigid control is necessary, the program will include a list of those finishers who consistently produce the desired results. Interested converters will be referred to this group of finishers, a group that will be enlarged as quickly as information and commercial experience can be supplied them.

Approved Converters

Interested converters may submit their lines of Teca blends to the A. M. Tenney Associates, Inc., sales representatives of the Tennessee Eastman Corporation, for evaluation. After such evaluation, suggestions for necessary changes, if any, will be made. Once approved by the American Institute of Laundering, and with the necessary check-test routine established, the converter may then offer his fabrics as Laundry-Tested and Approved to the cutting trade.

Approved Cutters

Any garment manufacturer wishing to use the Laundry-Tested and Approved Seal on his merchandise signifying complete approval of his garment will first of all use fabrics from the approved group. In addition, the cutter shall be required to use thread, buttons, and other trim which has been approved by the Institute for this purpose. In addition, Institute inspection of the cutter's production will be undertaken to determine sizing specifications and other necessary inspection factors. The Institute is placing seven inspectors in the field for this purpose.

The garment then goes to the retailer carrying a full warranty of satisfaction on all points of launderability.

Such garments, when bearing a permanent label incorporating the Seal, will be accepted for reconditioning by the laundries of the country. While string tags may be used to identify this merchandise, the laundries will only place their full cooperation behind those garments incorporating a permanent label so that they can be identified.

Initial emphasis will be placed on men's and women's sportswear and on washable dresses made from Teca blends of spun rayon.

A thorough-going merchandising plan will promote the program. Lists of approved products will be circulated to the retail trade. Lists of approved fabrics and trim will be constantly available to the cutting trade, and new fabrics and constructions that have proven their launderability will be immediately merchandised to both the converting and cutting trades.

The 3,500,000 weekly packages of laundry delivered to the home by the Institute's laundry members will be utilized as a medium for distributing information on approved garments. The 14,000 truck driving salesmen of the laundry industry are already selling the Seal to the consumer and will actively solicit the reconditioning of spun rayon garments containing the Seal.

• CIBA REVIEW

Copies of *Ciba Review*, No. 35, for September, 1940, have recently been distributed. Featured in this issue is "The Hat." Articles are described by the following titles: The Head-gear of Primitive Peoples; The History of the Hat; The Making of a Hat; Modern Hat Manufacturing and Dyeing; Notes. All of the articles are profusely illustrated.

• CALCO RELEASE

Chrome Yellow CGW-100%, an economical, easily applied yellow dye for wool, is curently being featured in a bulletin issued by the Calco Chemical Division, American Cyanamid Company.

It is stated that, with dyers of wool, this color will have unusual interest in two respects: first—as a component for Government Olive Drab shades; second—the same fastness properties, flexibility of application and moderate cost that make it useful for government work, give it great utility for general use as well. Another feature is the unusual flexibility of Calco Chrome Yellow CGW-100%. It may be applied by either the top-chrome, metal-chrome or the bottom-chrome methods with but slight variation in shade and no variation in other properties. A folder, fully describing this color and including complete fastness tables, is available to all interested. Address requests to Calco at Bound Brook, New Jersey.

• TO ADDRESS DRUG SECTION

The Honorable Millard E. Tydings, United States Senator from Maryland, will be the guest speaker at the next monthly luncheon on November 28, 1940, of the Drug, Chemical and Allied Trades Section of the New York Board of Trade. The affair will be held in the Southeast Ballroom of the Hotel Pennsylvania at 12:30 P. M.

Senator Tydings' address will be on a subject of national interest and should prove interesting to all. It will be recalled that he was the co-author of the Miller-Tydings "Fair Trade" Act, and in addition he is an outstanding authority on national and international trade. A veteran of the Senate and chairman of the Committee on Territories and Insular Affairs, Senator Tydings is well qualified to bring a message vital to businessmen.

All are cordially invited to attend. Reservations are being accepted by John C. Ostrom, Secretary, at 41 Park Row, New York City. The charge per plate is $1.50.

• APPOINTED REICHHOLD MANAGER

On November 1st, Oscar F. Johnson joined the sales organization of Reichhold Chemicals, Inc., Detroit, Michigan, in the capacity of District Manager of their Chicago territory. Mr. Johnson, as is generally known throughout the Chicago area, has contacted the paint, varnish and printing ink trade in that part of the country for some twenty-odd years, during most of which time he sold and serviced RCI products through a former affiliation with the S. H. Stewart Company, manufacturers' agents. He has a host of friends in and around Chicago, most of whom will wish him the very best of success in his new undertaking.

Rayon Dyeing and Finishing

(Continued from page 634)

Another cause of these weft bars was found to be unsuitable steaming conditions, where there was a heavy condensation of moisture on the yarn. This caused a stewing effect which seemed to reduce the affinity of the yarn for dyestuffs; although the size or tint may have been affected in such a manner as to produce a resistance to dyeing. We are assuming, of course, that no appreciable difference in twist is present in the yarn.

Where the length of the pick in the light bar is found to be shorter than normal, it can be suspected that the yarn was in a strained condition when woven into the cloth and that a subsequent contraction has taken place while finishing. This fault can be caused by excessive tension on the yarn or too high moisture content at some stage of the processing. It is a well-known axiom that the higher the moisture content in a viscose yarn the more readily will it stretch, *i.e.*, the less tension is required to cause a definite extension in length.

Weft Bars Due to Cloth Structure.—When there is no actual difference in shade between the threads, the bars are evidently caused by some variation in the structure of the cloth. In this case the picks per inch should first be carefully counted. In some instances weft bars of this type also show a difference in pick length. Although we have not been able to discover any satisfactory proof of the cause of such a defect, it seems possible that it also may be due to a tension fault, even though the dyeing of the yarn itself is not affected and it seems probable that light reflection variations give the impression of unlevel dyeing.

We have found many instances of weft bars in the alpaca type of crepe fabric, where a plain open thread and a creped thread are twisted together, to be due to variations in the coverage of one thread over the other. Whether the two ends are both viscose or the open yarn acetate and the crepe viscose, they are usually of different depths of shade. If in one case the open yarn has more coverage over the crepe than in another case, there will be an appreciable difference in the apparent shade of the two doubled yarns. This difference in coverage is caused by variations in the tensions on the threads when doubling. Crepes woven with 2-ply yarns are also susceptible to the other causes of weft bars which are outlined above. Since it is almost impossible to get a union match between the two yarns, that which is more exposed due to variations in doubling will obviously cause an apparent variation in dyeing affinity.

Streakiness in Crepes.—Light dyeing streaks in crepe yarns have been found which occurred at intervals along the thread equal to the traverse length of the yarn between the flanges of the steaming spool; the yarn on the steaming spools had obviously been quite wet close to the flanges, as was shown by the tint, and probably also the size, having been washed back along the thread. The light-dyeing places coincided with the spots where the tint and size had become concentrated at the extremities of the wet places on the steaming bobbins. This fault was eliminated by putting in a modern steaming equipment so that water

was prevented from condensing around the flanges of the steaming spools.

There was one case of blackish streaks occurring on a crepe fabric, and this also showed the period between the flanges of the steaming spool. These discolorations gave very definite tests for copper and further investigation showed that a sheet of copper had been used to cover the roof of the steaming chamber. When this copper sheet was removed, the black marks ceased to appear upon the yarn. Evidently water condensing on the roof had become polluted with copper salts, probably verdigris, and had then dripped down on to the inside of the bottom flanges of some of the spools which were not adequately covered.

Warp Stripes.—Some of the different causes of warp stripiness, found in various complaints from customers, are as follows:

(*a*) Reediness, which is an uneven spacing of the warp ends, and which among other things is caused by bent wires in the reed. This is usually visible to some extent in the grey cloth but becomes more distinct on dyeing.

(*b*) Uneven sizing of the ends. In this case, although the sizing materials may be completely removed from the yarn in scouring, stripiness can still be seen in the cloth. The uneven distribution of size causes varying stiffness of the ends and more or less resistance to crimping when woven in. Once the cloth has been woven this variation in the crimp remains and cannot altogether be taken out in the finishing.

Scouring and Sizing Streaks.—By far the most complaints due to warp streaks that we receive are in some way connected with the sizing and scouring. Everyone seems to have their own pet formula for size mixtures, together with their own pet plasticizers or softeners, and usually not one of these firm believers in their own mixtures have ever considered that practically all of them are subject to alteration due to temperature and fermentation, and consequently can affect any work done by subsequent departments before the cloth is ready for sale. Until the sizing departments realize that the heavy stiff size that has been baked on the yarn, for instance, will form practically an insoluble compound, the dyers will continue to have difficulties in dyeing.

The presence of dissolved and especially undissolved air in a sizing solution, when coupled with varying degrees of alkalinity, also causes varying degrees of fermentation; in fact, many sizing solutions that I have seen in various sizing sheds have been used for so long a period without chemical tests being made that they actually have a foul smell and show definite signs of bacteria having been formed and bred in the solutions. With the more general use of automatic control of temperature of the size bath and drying cans on the slashing machines, many of these troubles are becoming less frequent, but the chemists will have a lot of research to do in order to help the dyer on the matter of sizing and sizing conditions before the dyer can eliminate the presence of warp streaks in piece dyeing.

Tendering by Vat Dyes.—We had a case of a curtain material containing matt yarn and dyed with a yellow vat dyestuff, which tendered rapidly in use. The curtains had been exposed to weathering at the bottom ends, where they had evidently often been wetted by rains. In this particular part the material had even begun to fall apart when brought to our notice. The major part of the curtains, which had probably been exposed to strong sunlight, also showed a poor tensile strength but was nevertheless in much better condition than the bottom part, which had been wet. Only a narrow strip of the material along the top and down one edge, where the curtain had been protected from strong sunlight by the window sash, showed normal strength. Many of the yellow vat dyestuffs exhibit this tendering effect on viscose rayon when exposed to bright sunlight and moisture. This is the case even with lustrous viscose, but when a yarn delustered with titanium dioxide is used the effect becomes much more pronounced. It appears that the delusterant acts as an accelerator of cellulose degradation under these conditions.

Tension Effects.—These are usually evident in woven goods as "shiners" in the weft and tight ends in the warp. In knitted goods there is a variation in the size of the loops as a result of strained yarn. No correction can be made for this fault in the dyeing.

As is now fairly well realized, viscose yarn can be strained by processing under too great a tension or by processing when its moisture content is too high. Very often a combination of these two factors is found to be at the bottom of the trouble. A strained yarn will commence to contract to a certain extent in the air-dry condition and bad faults of this kind can be seen in the grey goods, but by far the greater amount of contraction occurs when the strained yarn is wetted out in the finishing and subsequently dried. In woven goods the contraction of the stretched part of the yarn causes it to take on less crimp and so lie flatter in the cloth. This results in a different reflection of light and causes the affected yarn to appear more shiny than the normal part; hence the name "Shiner."

To prevent faults of this kind the moisture content of the yarn should be kept constant (this is especially true of dense packages such as cones and pirns) and the minimum tension for good processing should be applied according to the denier of the yarn.

(3) DYEING FAULTS IN THE PRODUCTION OF RAYON

"Control" in Yarn Production.—There are many factors actually in the production of rayon which can cause varying dyeing affinity in the finished product. All these factors are known and consequently rayon as produced now is more free of different dyeing affinities than any of the natural fibers.

The most important possibilities of varying dyeing affinity are due to differences in the chemical age of the viscose, differences in tension during spinning and differences in the amounts of the constituents in the coagulating bath. It is a matter of routine for the chemist to keep factors

under control, such as the strength of desulfurizing, bleaching and acid solutions.

The age of viscose is reflected immediately in a shorter skein circumference and a totally different shaped cross-section of the filaments, both due to abnormal contraction after finishing and drying, but by chemical determinations of the salt test of Hottenroth test the chemical age and actual age are readily controlled.

The spinner or workman can cause the second difference by allowing the spinning thread to miss the bottom godet. The top and bottom godet (these are actually transfer wheels) are travelling at different speeds and according to the amount of difference in these speeds a certain degree of tension or stretch is imparted to the thread, which is quite plastic at that stage, so that if the bottom godet is missed, that particular thread is of a different dyeing affinity from that of its neighbor. As a check on such possibilities, special patrol men or fault-finders are employed constantly in checking up on the actual spinner who sets up the ends.

The varying constituents in the coagulating bath have different effects on the actual coagulation to such an extent that the cross-sections can vary from an absolute circular smooth cross-section to a very irregular, deeply serrated, indented cross-section. These indentations or serrations are reflected on the linear appearance and act as capillaries when dyeing and consequently are a much darker dyeing section.

How well this control is maintained and observed is noted in the fact that many customers use inferior qualities without experiencing any dyeing difficulties. These factors enable us to make light and dark dyeing purposely for dyeing tests only. When woven up into light and dark dyeing stripes the properties of a dyestuff or a mixture of dyestuffs can then be accurately obtained before using on a production bases.

Spun Dyed Rayon.—One of the latest developments is the production of spun dyed rayon. Selected vat dyes are introduced in the viscose in the "leuco" state before the thread is spun. The viscose is spun in the normal way into cakes and the cakes of yarn are processed in the standard manner, the colors being properly developed in their progress through the bleach machines. They are particularly fast to light, washing and other treatments.

It is spun dyed Fibro that has gone ahead in this direction more than the continuous filament, as four colors and black are already available and it is the ease in which blends of colored black and white Fibro can be obtained that has caused its success.

If only standard shades could be made on a large production scale, sufficiently large to warrant isolating viscose tanks for particular colors, then dyed continuous filament yarns could easily be obtained. Even if the original yarn is 100 per cent first quality, subsequent dyeing, drying and spooling must spoil its quality to some degree no matter how carefully the operations are carried out, but with spun dyed yarns first quality yarns are obtained in exactly the same manner as ordinary yarns direct from the rayon manufacturers.

An interesting development spun in the same way as spun dyed yarns is the spun dyed white which is obtained by the introduction of a slight blueing agent in the viscose, the object of which, of course, is to obtain a very white yarn without any extra bleaching, resulting in a stronger yarn with less tendency to degradation.

Selection of Level-dyeing Dyestuffs.—The most recent literature which we have on this subject is a paper entitled "A Classified List of Direct Dyes for Use with Viscose Rayon" by J. Boulton, of the Textile Research Laboratory, Courtaulds Limited, Bocking, England.

In some quarters dyestuffs are purchased only on the basis of their cost and fastness properties; level dyeing is not considered at all and the rayon is expected to give perfect results with any dyestuffs. On the other hand, there are some dyers who consider the question of level-dyeing in selecting their colors and, of course, obtain much better results with fewer complaints about the yarn. We do not think that the cost of the dyestuff ought to be a serious consideration where the desired results can be obtained by substituting a more expensive color for a cheaper one that has been given unlevel dyeings. We do think that the dyers should be asked to give this question of selecting for level-dyeing more serious consideration. Each dyer should endeavor to develop level-dyeing combinations wherever possible and we believe that then many complaints would cease to arise.

• CLASSIFIED • ADVERTISEMENTS

The rate for "Position Wanted" advertisements in this column is 2 cents a word—with a minimum of 50 cents per insertion. For all other types of advertisements—i.e., help wanted, machinery or supplies for sale—the rate is $5.00 per column inch or less per insertion.

FINISHING PLANT MANAGER: Has specialized in men's wear cottons. Fully familiar with preparatory work, dyeing, printing, finishing and knows the requirements of the men's wear trade through years of experience. Will accept reasonable connection with plant desiring to enter this type of work or position as assistant in plant already established. Write Box No. 267, American Dyestuff Reporter, 440 Fourth Ave., New York, N. Y.

POSITION WANTED: Chemist to supervise the dyeing and processings of rayon, acetate, cotton, also of Lastex fabrics—can take charge of chemical control, improvements, economy and research. Experience with leading organizations. Write Box No. 268, American Dyestuff Reporter, 440 Fourth Ave., New York, N. Y.

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